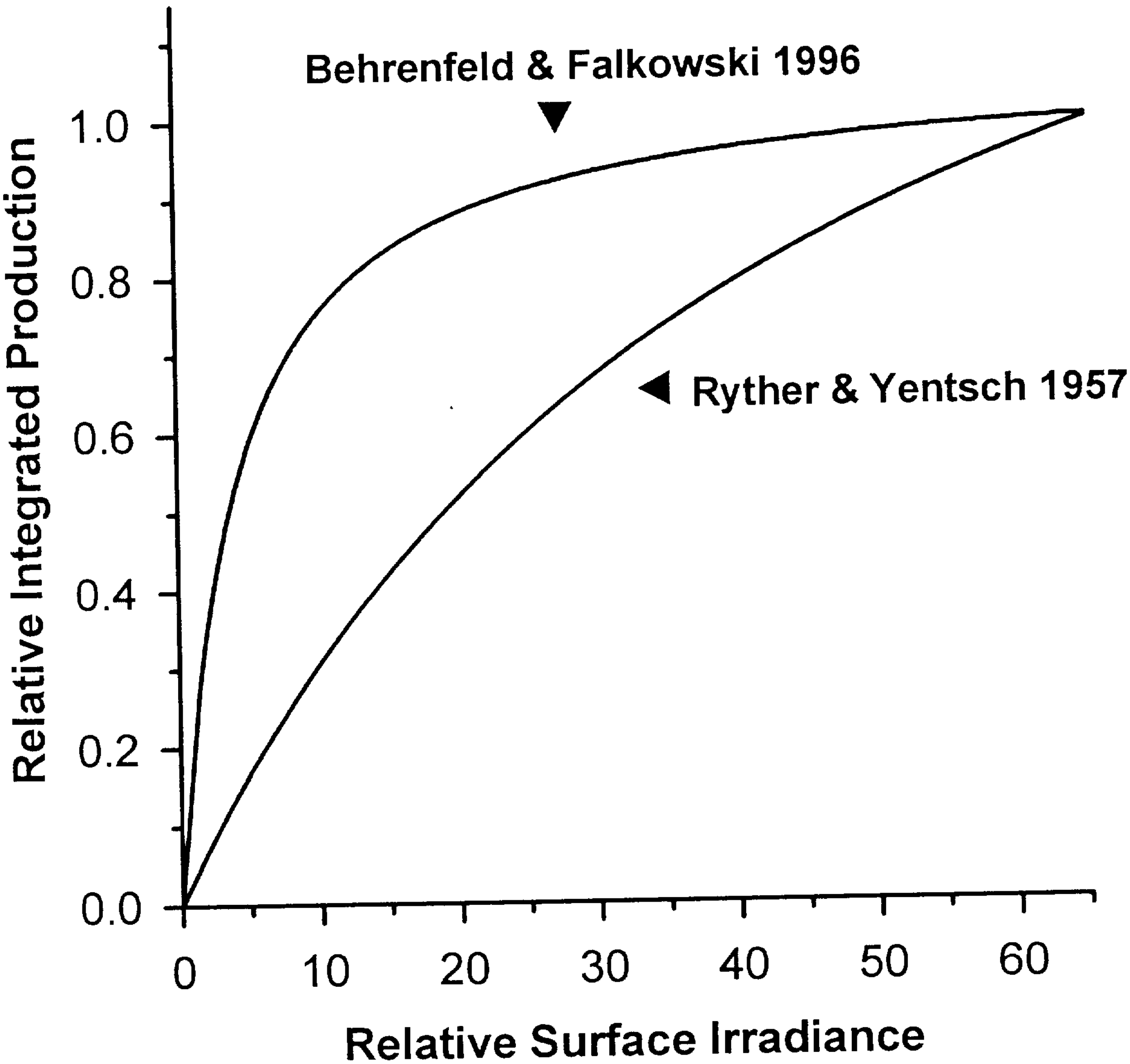
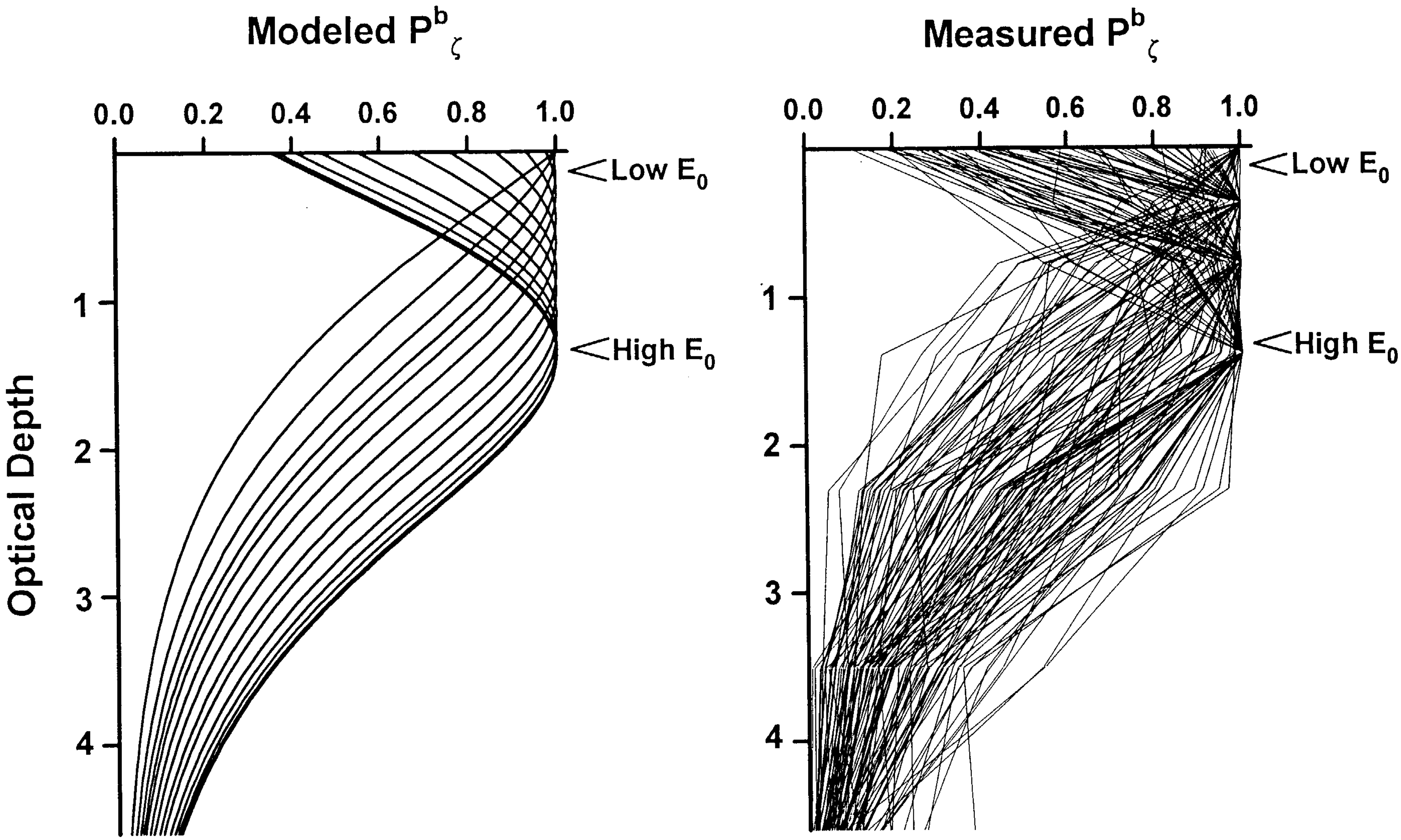
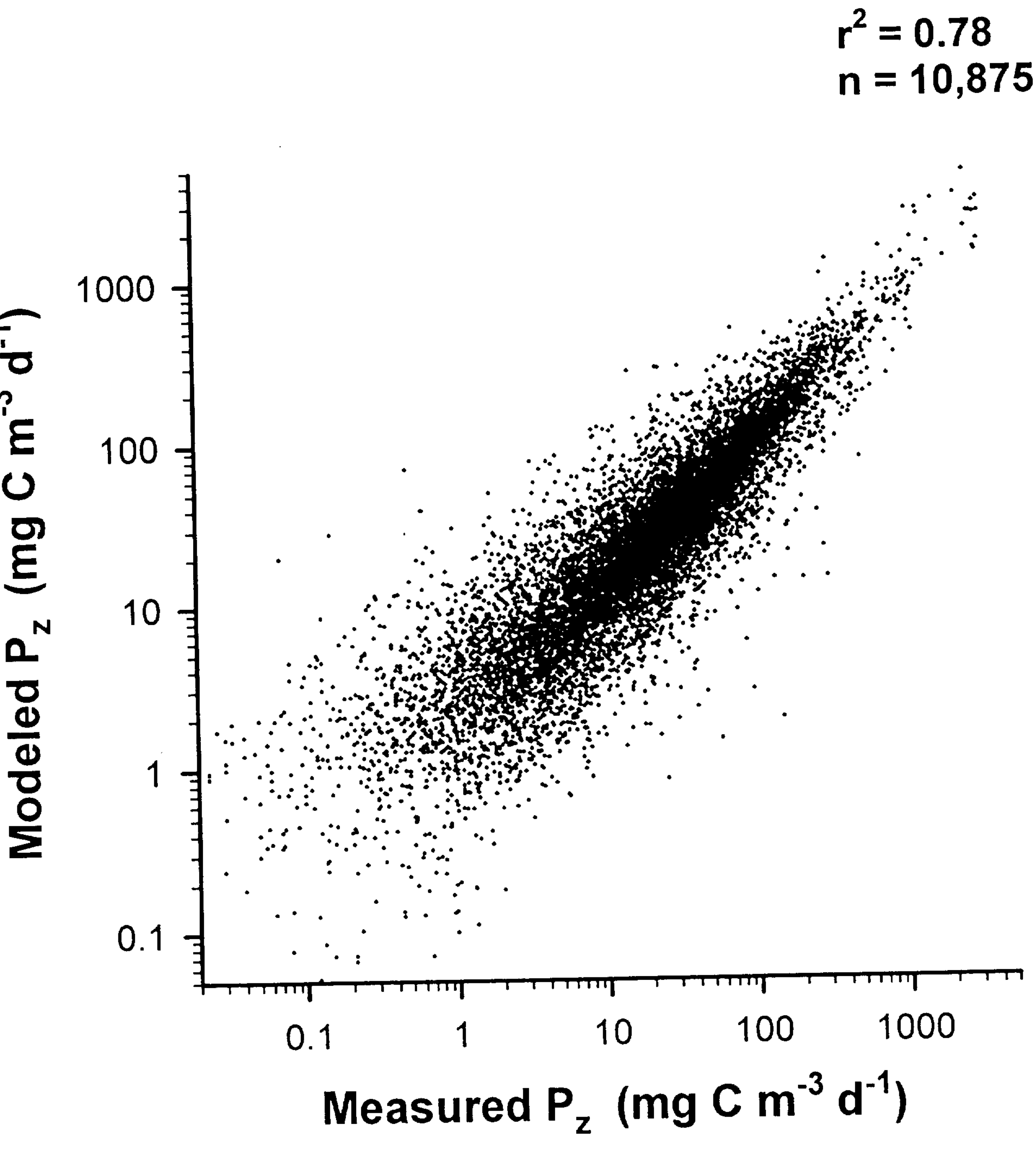


Behrenfeld & Falkowski 1996
Ryther & Yentsch 1957
Relative Integrated Production
1.0
0.8
0.6
0.4
0.2
0.0
0
10
20
30
40
50
60
Relative Surface Irradiance

-- Full model of Behrenfeld & Falkowski, 1996 --



-- Full model of Behrenfeld & Falkowski, 1996 --



$$PP_{eu} = 0.43 * Chl_{eu} * E_o$$ (Falkowski 1981)

$$PP_{eu} = Chl_{eu} * P^b{}_{max} / K$$
$$\approx Chl_{eu} * P^b{}_{opt} * Z_{eu}$$
(Balch & Byrne 1994; Smith & Baker 1978; Eppley et al. 1985; Banse & Yong 1990)

$$PP_{eu} = Chl_{eu} * P^b{}_{opt} * Z_{eu} * D_{irr}$$ (Wright 1957)

$$PP_{eu} = Chl_{eu} * P^b{}_{opt} * Z_{eu} * f(E_o)$$ (Ryther & Yentsch 1957; Talling 1957; Lewis et al. 1987)

$$PP_{eu} = Chl_{eu} * P^b{}_{opt} * Z_{eu} * D_{irr} * f(E_o)$$

(Behrenfeld & Falkowski 1996; abridged model)

$$PP_{eu} = P^b{}_{opt} * \int_{z=0}^{Z_{eu}} PE_{rel} * C_z * dz$$ (Ryther & Yentsch, 1957)

$$PP_{eu} = P^b{}_{opt} * D_{irr} * \int_{z=0}^{Z_{eu}} PE_{rel} * C_z * dz$$

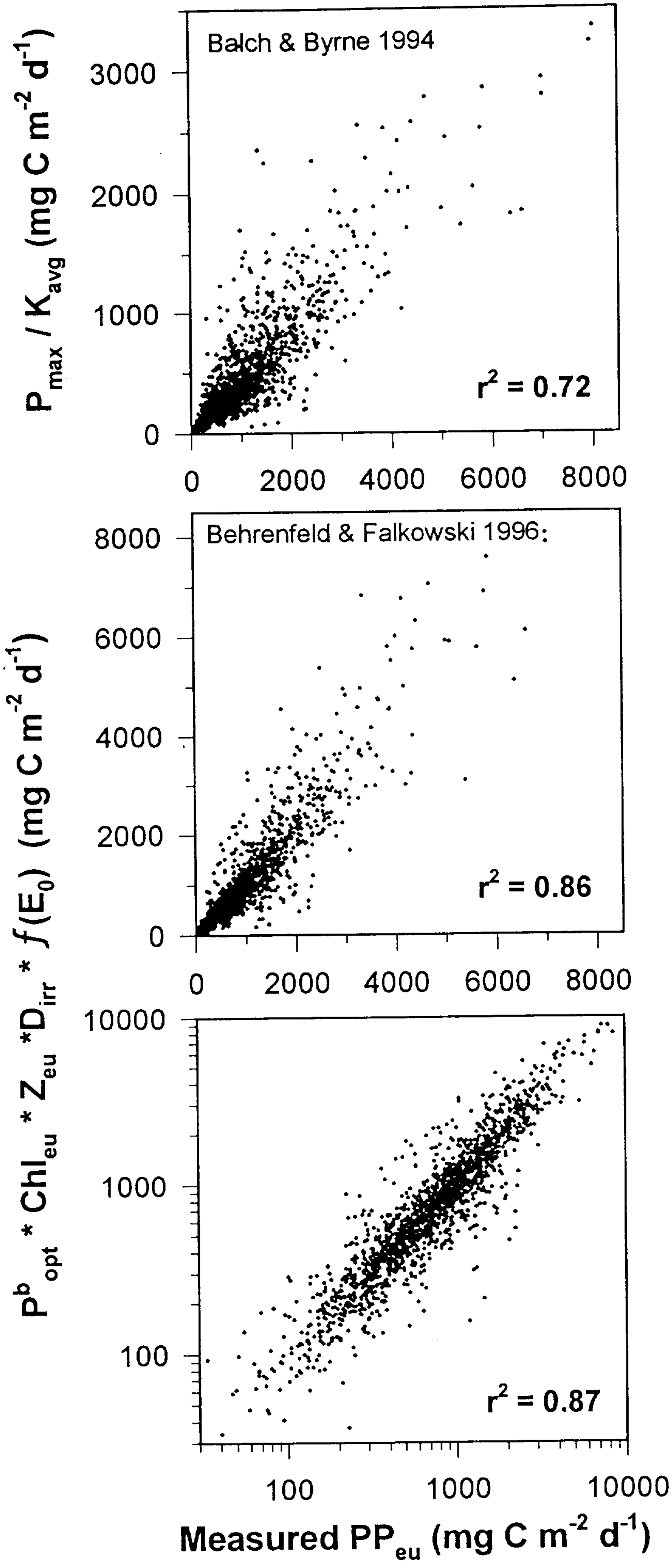
(Behrenfeld & Falkowski 1996: full model)

$$PP_{eu} = P^b{}_{max} * D_{irr} * \int_{sunrise}^{sunset} \int_{z=0}^{Z_{eu}} P\text{-}I * C_z * dz$$

(Bannister 1974: using Vollenweider (1965) & Fee (1969))

$$PP_{eu} = f\,(E_{z,\lambda}, a^*, \alpha, \beta, P^b{}_{max})$$

(Platt and Sathyendranath 1988; Morel and Berthon 1989; Morel 1991; Platt et al. 1991; Longhurst et al. 1995; Antoine et al. 1996)



Balch & Byrne 1994
r² = 0.72
Pmax / Kavg (mg C m-2 d-1)
Behrenfeld & Falkowski 1996:
r² = 0.86
Pbopt * Chleu * Zeu *Dirr * f(E0) (mg C m-2 d-1)
r² = 0.87
Measured PPeu (mg C m-2 d-1)

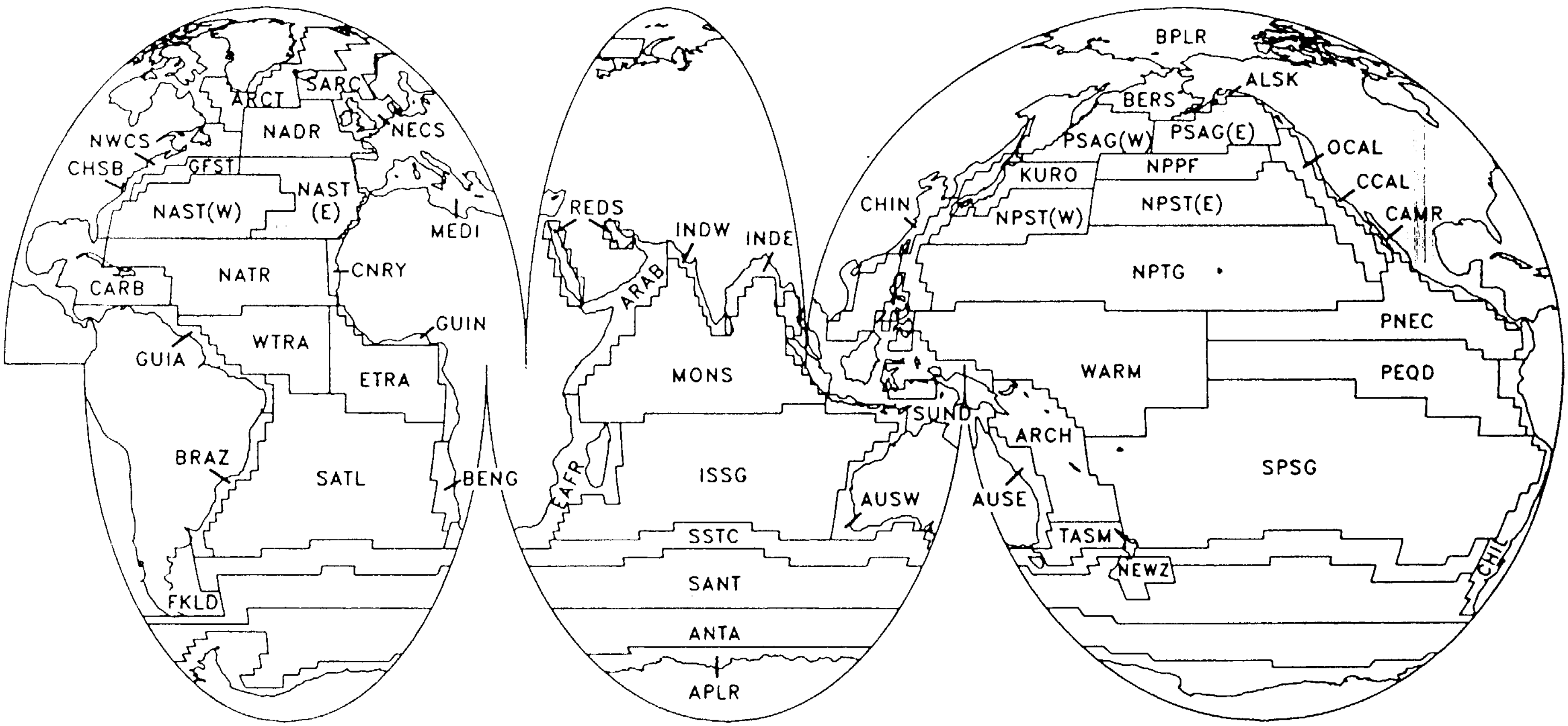
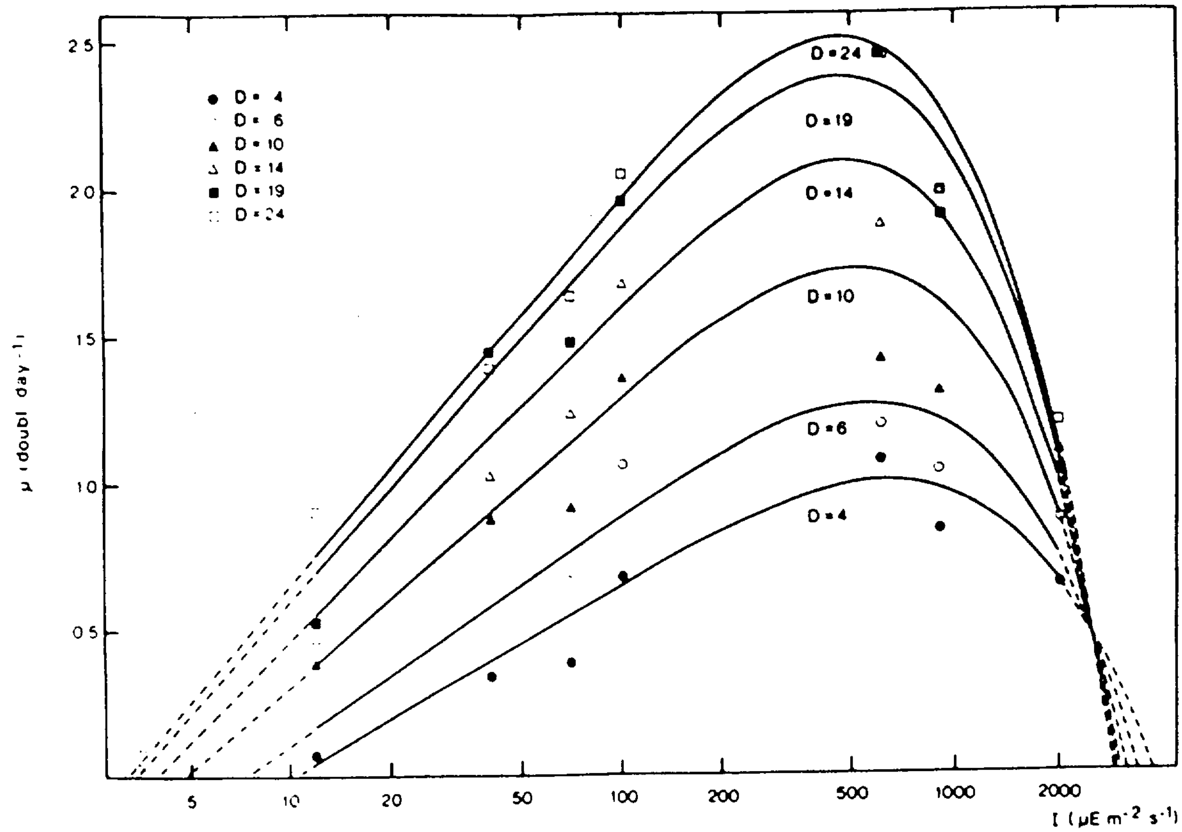


Fig. 2. The 57 biogeochemical provinces used as the compartments for computing seasonal primary production at the global scale; see the text for an explanation of the abbreviations. For the purposes of this computation, boundaries were established on a 2° grid to represent the approximate mean annual shape and location of each province. This approximation suffices for this demonstration, but is a simplification easily improved upon when the method is applied to global sea-surface chlorophyll fields obtained routinely by orbiting radiometers in the future.



E.Sakshaug and K.Andresen

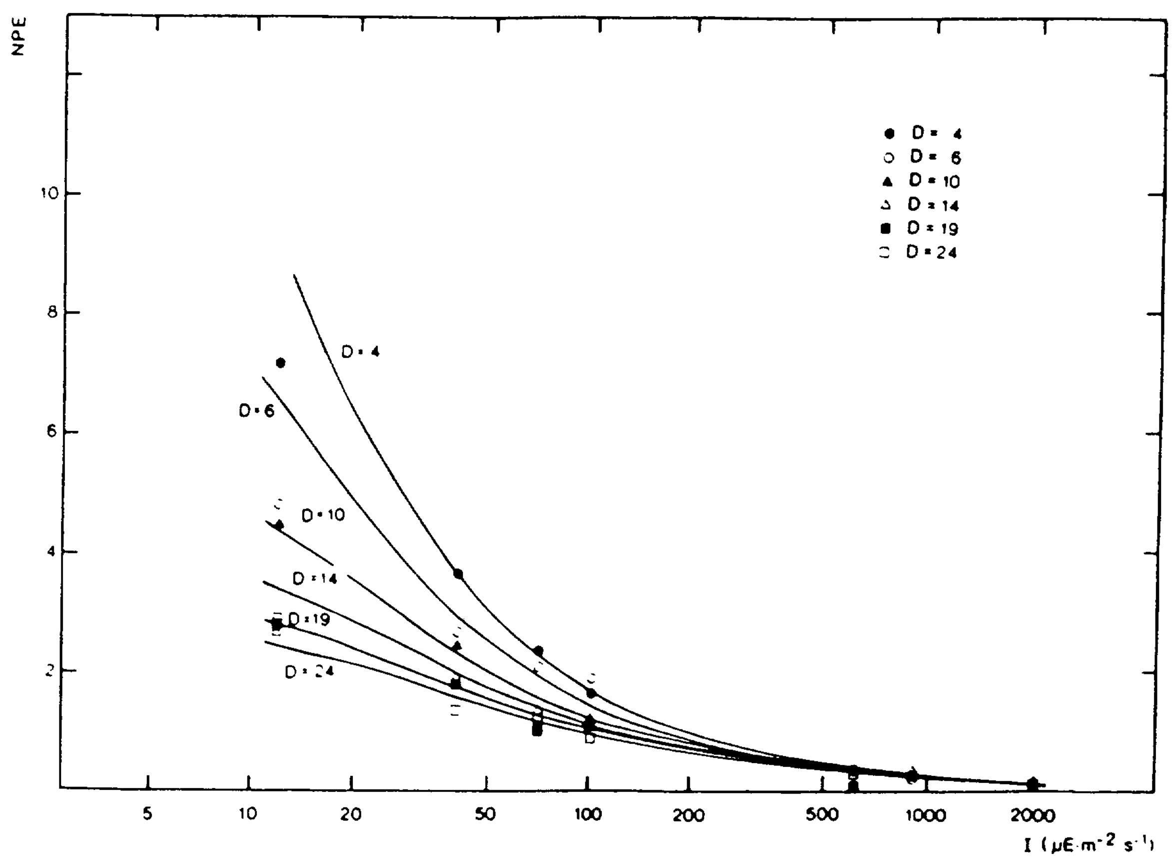


Fig. 3. Net production efficiency (NPE); curves are based on Equation 5. NPE is defined in the text.

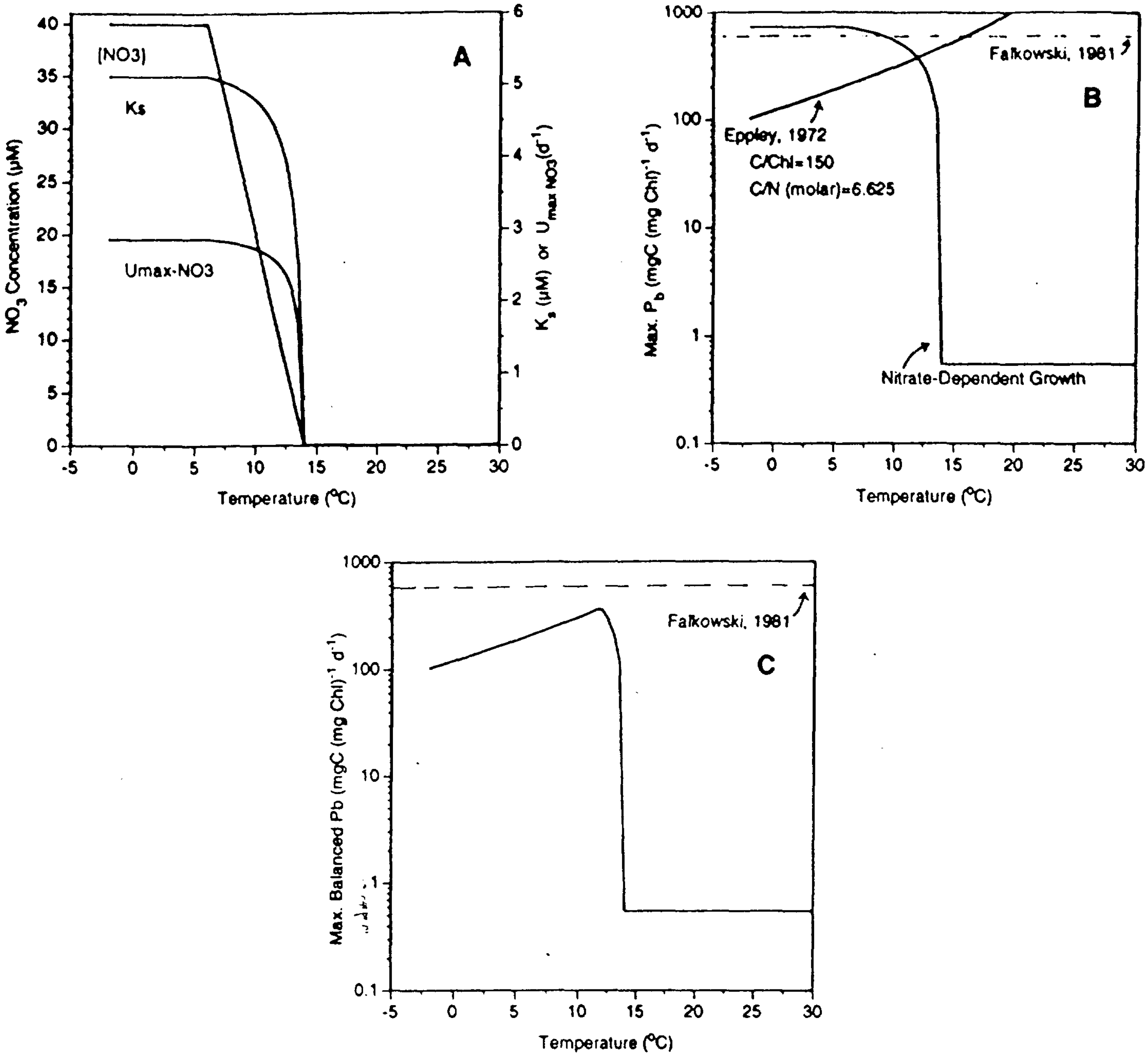
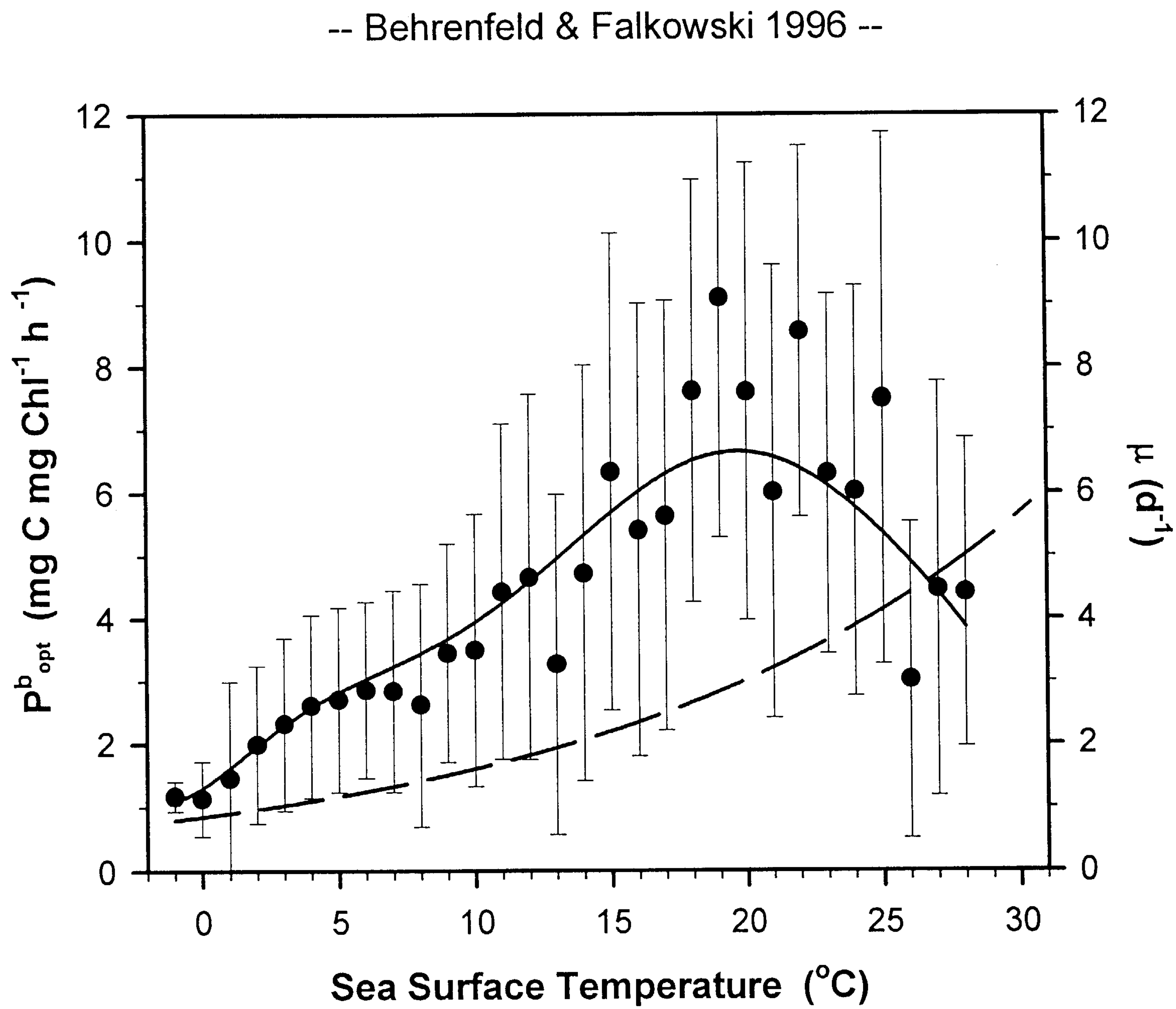


Figure 6. (a) Predicted nitrate-temperature relationship between 20°N and 29.99°N described by *Zentara and Kamykowski* [1977]. Right axis shows predicted Michaelis-Menten coefficients predicted from (4) and (5) (see also Figure 2). (b) *Eppley* [1972] relationship for maximum possible carbon assimilation as a function of temperature. The curve is based on (1) and (2) and assumes a carbon : chlorophyll ratio of 150 and a C/N ratio (molar) of 6.625. Also shown is the predicted nitrate-dependent growth based on Michaelis-Menten coefficients given in Figure 6a. This growth is given as carbon equivalents. The absolute maximum theoretical carbon assimilation that could be sustained under 24 hours of daylight is shown for reference (576 g C g Chl^{-1} d^{-1}). Obviously, a more reasonable theoretical maximum value for this latitude will be about half this value (300 g C g Chl^{-1} d^{-1}). (c) Maximum balanced C/N growth based on temperature and nitrate that can be sustained given the two curves in Figure 6b. Note the highly nonlinear nature of the function.



-- Behrenfeld & Falkowski 1996 --
P^b_{opt} (mg C mg Chl^{-1} h^{-1})
μ (d^{-1})
Sea Surface Temperature (°C)
0
2
4
6
8
10
12
0
5
10
15
20
25
30

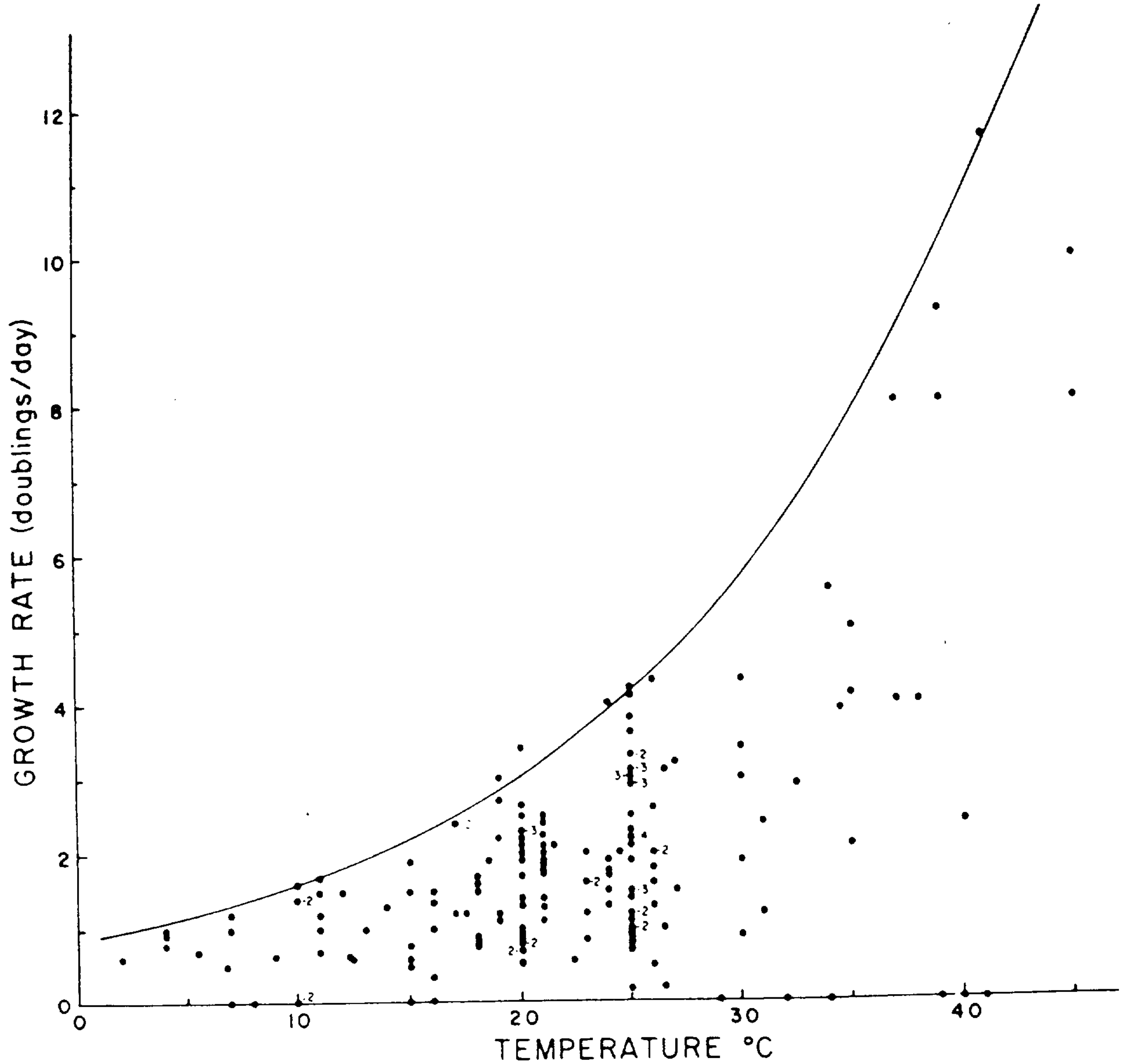


FIGURE 1.—Variation in the specific growth rate (μ) of photoautotrophic unicellular algae with temperature. Data are all for laboratory cultures. Growth rate is expressed in doublings/day. Approximately 80 of the points are from the compilation of Hoogenhout and Amesz (1965). That listing is restricted to maximum growth rates observed, largely in continuous light. The figure also includes additional data, mostly for cultures of marine phytoplankton, from the following sources: Lanskaya (1961), Eppley (1963), Castenholz (1964, 1969), Eppley and Sloan (1966), Swift and Taylor (1966), Thomas (1966), Paasche (1967, 1968), Hulburt and Guillard (1968), Jørgensen (1968), Smayda (1969), Bunt and Lee (1970), Guillard and Myklestad (1970), Ignatiades and Smayda (1970), Polikarpov and Tokareva (1970). The latter papers include about 50 strains of marine phytoplankton. The line is the growth rate predicted by Equation (1), i.e., the line of maximum expected μ. Small numbers by points indicate the number of values which fell on the point.

Modelling P^b_{opt}

1) $P^b_{opt} = 3.7$ (Ryther & Yentsch 1957)

2) $P^b_{opt} = f(\phi_{max}, I_K)$ (Bannister 1974)

$\phi_{max} = 0.06$

3)